KINEMATIC ANALYSIS OF TRUNK MOTION DURING FREE THROW AMONG WHEELCHAIR BASKETBALL PLAYERS - OBSERVATIONAL STUDY

DISSERTATION

Submitted for the partial fulfilment of the requirement for the degree of

MASTER OF PHYSIOTHERAPY (MPT)

(Elective-MPT sports**)**

By

Regn. No: 271550226

K. RANJITH KUMAR

Submitted to:

THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY CHENNAI – 600032.

APRIL - 2017

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This is to certify that the Dissertation entitled **"KINEMATIC ANALYSIS OF TRUNK DURING FREE THROW MOTION AMONG WHEELCHAIR BASKETBALL PLAYERS - OBSERVATIONAL STUDY"** was done by Bearing Regn. No: **271550226.** This work has been done as a partial fulfilment for the degree of Master of Physiotherapy done at **Mohamed Sathak A.J College of Physiotherapy**, Chennai and submitted in the year April 2017 to **The Tamilnadu Dr. M.G.R Medical University**.

Date:

Place: Chennai

Seal & Signature of Principal

……

Prof. R. Radhakrishnan, MPT., PGDHM.,
Mohamed Sathak A .J College of Physiotherapy

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Date:

Place: Chennai

Signature of Guide

…..…….

Prof. R. Radhakrishnan, MPT., PGDHM.,
Mohamed Sathak A.J College of Physiothe

CERTIFICATE

MOHAMED SATHAK A.J COLLEGE OF PHYSIOTHERAPY

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…… **……..……**

Internal Examiner **External Examiner**

Place: Chennai

Date:

DECLARATION BY THE CANDIDATE

I hereby declare that the Dissertation entitled "**KINEMATIC ANALYSIS OF TRUNK MOTION DURING FREE THROW AMONG WHEELCHAIR BASKETBALL PLAYERS - OBSERVATIONAL STUDY**" was done by me for the partial fulfilment of the requirement of Master of Physiotherapy degree. The dissertation had been done under the direct supervision and guidance of my Guide at **Mohamed Sathak A.J college of Physiotherapy**, Chennai, and submitted the same during the year April 2017 to the **Tamilnadu Dr. M.G.R Medical University**.

Date:

Place: Chennai

…..…….

Signature of the Candidate

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I extend my thanks to my Parents, family members and my Friends for their immense support and help for all these years in my studies.

INDEX

ANNEXURES

1. ABSTRACT:

Objective: To analyze the kinematics of trunk motion during Free Throw among wheelchair basketball players.

Design: Observational study

Subjects: 20 wheelchair basketball athletes were divided into two groups, according to International Wheelchair Basketball Federation (IWBF) classification (**Group 1**: 3.0- 3.5 point players and **Group 2**: 4.0- 4.5 point players).

Setting: Nehru Outdoor Stadium (Basketball Court)

Methods: 20 wheelchair basketball athletes were allowed for 5 free throw shots. Video camera was used for observation over the players shooting side with the distance of 5m from free throw line to cover the player sagittal view and successful shot. Using the kinovea software, analysis of trunk inclination angle was done during the free throw with the reference point on shoulder and lower angle of the wheelchair of players shooting side.

Results: The Mean (-SD) values for the analysis of trunk motion obtained for overall free throw shots in group-1 players (3.-3.5) is 25.18 -4.868, and Group-2 players (4.0-4.5) is 13.40 -5.810, thus the study shows there is a significant difference among Group 1 and Group 2 players.

Conclusion: Players of Group 1 and Group 2 rely on different kinematics strategies of trunk to produce successful free throw shot. Thus increases player proficiency in skill of free throw shooting may help to lead their team to victory.

2. INTRODUCTION

Wheelchair basketball was founded shortly after World War II as a rehabilitation exercise for injured veterans (Malone et al., 2000). Today, wheelchair basketball is one of the most popular, exciting and fast paced high calibre sport played competitively in over 75 nations (Malone et al., 2000; Goosey-Tolfrey et al., 2002).

Wheelchair basketball is included in the Paralympic Games. The Wheelchair Basketball World Championship is played two years after every Paralympic Games. Major competition in wheelchair basketball comes from Canada, Australia, the United States, Great Britain, the Netherlands, and Japan.

Wheelchair basketball is regarded as one of the highest profile disability sports (Goosey-Tolfrey et al., 2002). As the level of competition increases, players need better ways to optimize their game skills. One such skill is that of free throw shooting. In wheelchair basketball, the functional level of the players can vary greatly depending on their spinal cord level of disability. For this reason, a classification system was developed to take into account their level of physical disability.

The rules of the game are same as the traditional basketball game except for modifications to allow for the use of wheelchairs (Owen, 1982). Players are looking to optimize their skills in the game of wheelchair basketball since the aspect of competition has been introduced the popularity of wheelchair sports increases, new players will need to learn the necessary skills of the game.

The IWBF Player Classification System was developed and proposed by Horst Strohkendl of Germany. It was formally adopted by the basketball playing nations in 1982, and used for the first time in a major International tournament at the 1984 Paralympics in England. Over many years the Player Classification System has evolved to be where it is today. The strength of the system is the level of understanding amongst players and coaches, and the open communication and interaction between teams and classifiers.

The current international system divides players into eight classes (Class 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5) based on trunk movement and sitting balance (www.iwbf.org/ classification/functions.htm). For example in shooting, a Class 1 player would be described as having a significant loss of stability in the trunk, whereas a Class 4.5 player is able to move the trunk forcefully in all directions. Players in class 1.0 are not able to perform active

rotation of the torso and lack abdominal muscles. Players in class 2.0 can perform active rotation of the torso and have active trunk stability however they cannot fix their pelvis or move their torso in the frontal and sagittal planes. Players in class 3.0 have mobility in the frontal plane and therefore lean forward and return to an upright position. Players in class 4.0 have active mobility in the frontal and sagittal planes and can therefore lean forward and to the sides and return to an upright position. Half point classes were added for cases in which a player has too much functional ability for the lower class, but not enough for the higher class. Within this system, each player is designated a point value and the total point value of the five players on the court cannot exceed 14 points.

According to Brancazio (1981), a person's performance on the basketball court can be improved through the study and application of kinematics and Newtonian mechanics. The knowledge of an optimal free throw movement pattern could help to improve the skills of current players. Many studies have addressed the optimal patterns for sport skills in order to increase competence in athletes. Currently, there are few studies that attempt to optimize skills in wheelchair sports.

In the case for able-bodied basketball, success is largely dependent upon the ability of the player to put the ball through the basket. The skill of shooting has been acknowledged as one of the most important in the game (Hay, 1994). Statistics from the 1998 Gold Cup Men's World Wheelchair Basketball Championship showed that at this high level of competition, 21.9 – 8.4% of all shots were free throws, of which 52.4 – 14.3% were successful. Given that the free throw is a closed skill, then it is a shot that deserves specific practice in order for players to finely tune their shooting mechanics and pre-shot routine (Gayton, Cielinski, Francis- Keniston, & Hearns, 1989; Southard, Miracle, & Landwer, 1989; Southard & Amos, 1996).

Success in wheelchair basketball shooting is dependent upon a number of factors, including personal mechanics, chair positioning, arm strength, and trunk stability. During shooting, wheelchair basketball players generally align the wheelchair at an angle of 30-45 to the basket, depending on functional ability (Owen, 1982). Balance is of similar importance to that of an able bodied player; however, for the wheelchair player, the ability to control or maintain stability is affected by disability level. Chair design is often set up to optimize stability and manoeuvre ability in relation to the basketball task (center, forward, or guard). For example, class 1.0 players generally have a bucket seat sloping backwards away from the

basket. This position, with the knees raised, allows the player to utilize legs to better support the trunk and assist with stability (Yilla, La Bar, & Dangelmaier, 1998). In addition, some players from other classifications may use strapping around the hip and/or trunk region to restrict forward motion of the trunk and create a more up- right position of the body, thereby increasing stability. As the arm muscles are much smaller than the leg muscles, it is much more difficult to generate the necessary forces to shoot a free throw. However, several wheelchair basketball players have been shown to have shooting averages greater than 70% (Owen, 1982). This shows that with proper technique and practice, players in wheelchair basketball can achieve high free throw shooting percentages. Malone et al. (2000) found that the majority of missed wheelchair free throws fell short of the basket, indicating insufficient force or trajectory to reach the target. Goosey-Tolfrey et al. (2002) identified important factors affecting wheelchair free throw success to be personal mechanics, arm strength, and trunk stability.

Personal mechanics would generally lead to a short shot if the athlete released the ball with too low a speed or angle. A lack of arm strength would lead to a shot falling short, if the athlete was not able to generate enough force to release the ball with a high enough speed. A lack of trunk stability causes the shoulder to be positioned lower and thus, the ball is released from a lower position. With a greater distance to travel, the ball must be released with a greater speed. A lack of trunk stability will also make it more difficult to generate force at the shoulder, even with adequate arm strength, as the shoulder is not held in a stable position. The release angle and release velocity for a wheelchair free throw should differ significantly from that found to be optimal for standing players since wheelchair free throws are performed from a lower shooting position (Malone et al., 2002).

The Free Throw to be successful in wheelchair basketball, players must develop the fundamental skills of the game (Malone, Gervais, &Steadward, 2002; Schwark et al., 2004). One fundamental skill in need of development by wheelchair basketball players is free throw shooting. A free throw is a privilege given to a player that has been fouled by another player. The fouled player is given the opportunity to score one point by an unhindered shot for a goal from a position directly behind the free throw line (F.I.B.A., 1980).

The free throw should be the easiest shot in basketball since it is not contested. The free throw is classified as a closed, discrete skill as it is performed in a stable, predictable 4 environment with definite start and end points (Malone et al., 2000). Despite this stability, many players struggle with free throw shooting (Vancil, 1996).

Kinovea is a free software application for the analysis, comparison, measurements and evaluation, especially suitable for physical education teachers and bio mechanist. Kinovea is able to measure passive and active range of motion; the overview function is a summary image of the video Furthermore, it can be possible export the data to a spreadsheet with the results of motion analysis. Install the set for video recording, using a webcam, record the movements of the body, edit the video using Kinovea, place tracking markers on the person's body parts, start the analysis, export data to a spreadsheet, find position, velocity and acceleration, with this same data find the inverse kinematics of the body and then graph the results (Balsalobre-Fernandez *et al*., 2014).

Exercise and sports may be important for individuals with disabilities because of their limited physical activity in people with disability, sport and exercise participation can improve both physical and psychological health problems. Participation in sports can lead to increase self esteem, quality of life and reduction of anxiety.

2.1 AIM & OBJECTIVE

AIM:

To analyze the kinematics of trunk motion during free throw among wheelchair basketball players

OBJECTIVE:

To analyze the trunk motion in sagittal view.

2.2 NEED FOR THE STUDY

Wheelchair Basketball Federation of India (WBFI) is a registered National body. Our main objective is to promote wheelchair basketball sport for persons with physical challenges. We believe that access to sports plays a vital role in enhancing opportunities for differently-able people; leading to improved self-confidence, motivation, and social awareness.

Sports can be used as a tool to empower differently-able people within their communities and in society at large. We strongly believe that disability sports can play a major role in promoting social inclusion and improving the quality of life of differently-able people. We also believe that disability sports can become a gateway to employment, leadership development and for promoting accessibility.

Our vision is to enable large-scale participation and following for wheelchair basketball as a means to empower physically-challenged persons and to nurture strong state-level and national teams for Wheelchair Basketball in India.

To be a successful wheelchair basketball players require adequate fundamentals skills for victory.

The fundamentals skills involved (e.g. shooting, pushing, dribbling, and passing). In this, shooting can be considered as the most important skill for determining the score and outcome of a game.

In our country biomechanical analysis of sports persons with disability has not been widely studied in sporting skills, and also this kind of study will give physiotherapist and coaches insight knowledge of the muscular forces required for a good performance in sports activities and also physiotherapist can design a protocol for particular muscle strengthening, stretching, posture alignment or any correction in their biomechanical phase. Hence training of players for wheelchair basketball performance should be more standardized.

Thus the present study focuses on the kinematic analyzes of trunk motion during free throw technique in wheelchair basketball players.

2.3 HYPOTHESIS

NULL HYPOTHESIS:

Ho - There is no significant changes in trunk motion among 3.0-3.5 and 4.0-4.5 point players in wheelchair basketball.

ALTERNATE HYPOTHESIS:

H1- There is significant changes in trunk motion of players 3.0-3.5 during Successful free throw shot.

H2- There is significant changes in trunk motion of players 4.0-4.5 during Successful free throw shot.

H3- There is significant changes in trunk motion when compared between players 3.0-3.5 & 4.0-4.0 during overall free throw shot.

3. REVIEW OF LITERATURE

VIDEO ANALYSIS:

Bob Myers concluded that the takeoff in the jumping events is not easily analyzed with the human eye, hard to see this complex movement. Without a slow motion camera it is hard to see.

Thor Besier states that the ability of a coach to analyze these skills in detail using the naked eye is limited. Video allows you to view various skills in slow motion, again and again, and from different angles, which means you have an opportunity to analyze motion in great detail.

Andoni Morales Alastruey [2007-2008] states Video analysis help sports specialists to analyze games using video and images by simplifying the process of identifying, storing and retrieving important plays of the game.

Timothy R. Ackland, Bruce Elliott, John Bloom conclude…, Video analysis is a valid tool for measuring Range Of Motion.

Pedersen, Paul, Parks, Jannet, Quartenman, Jerome, Thibault, Lucie emphasis…, Video analysis will help us to collect necessary.

KINOVEA SOFTWARE:

Reham M. Abd El-Raheem, et al, (2015) states that, there were many measurement tools used in physical therapy field for ROM measurement, beginning with universal goniometry ending with 4D motion analysis device. Their reliability, validity was well established and widely accepted. Both of these measurement tools were cost affective and specific using tools, so the physical therapist in need to have a new, low cost, easily applicable, light weight, valid all the time, match with the new technology and accurate method for measuring the body ROM, the ideal measuring system is one that can be easy to use without the need to utilize sensors attached to the body and cheap.

Dr. Marco Cardinale states that I have recently downloaded the latest version of Kinovea, a freeware video analysis tool. The new version allows all sorts of analyses to be performed using this very simple freeware software. The beauty of the software is the fact that is free and is of very good quality.

Currell.k.jeukendrup A.E 2008 states that validity n reliability and sensivity of measure of sporting performance, sports medicine- page no: 297-317

Boris Bačić1,2 and Patria Hume2 concluded that Kinovea Were selected for task review based on user acceptance and functionality/utility testing matched with the task(s) requirements. The tasks that were able to be achieved using the available equipment, the specifics of how the tasks were achieved; Usability focus on coaching tasks was evident by intuitive task completion with a minimal number of steps required. Advanced annotation capability over video segments (real-time stop watch, perspective grid, translucent fade-in/out drawing elements) and export flexibility.

CLASSIFICATION

IWBF (June 2014) stated that classification is an important part of the game of wheelchair basketball but it does not rule the game, classification while being strict and adhering to the rules and regulation must be discreet and always respectful of the player as an individual.

Tweedy & Vanlandewijick 2010 states that the purpose of Paralympics system of classification is to increase participation in sport among people with disabilities by minimizing the impact of impairment on the outcome of competition each athlete's impairment should be evaluated and classified according to how much it will impact on the core determinants of the sports in which the athlete will compete.

FREE THROW

MILLER & BARLETT (1993) State during the shooting process is important in eliminating any extraneous body movement; as such movements must be compensated for at release. Players from trunk that players in group 2. The mean trunk angle at release for group further forward when compared to the 4.0 and 4.5 class players from group 2.

Movement of the trunk might interfere with the measurement in particular of the shoulder angle a local origin of the co-ordinate system, a point within the trunk segement, say the right shoulder joint to be reset then recalculate an axis system for movements of the humerus and trunk x-axis (shoulder), y-axis (perpendiular), z- axis (vertical), the co-ordinate system would then move as the athlete moved his body and you would still be able to measure his trunk movement accurately.

LAURIE A.MALONE et al, state that the championships being won or lost at the free throw line, the critical factor close game is ablity of players to make successful free throw. it is important aspect of wheelchair basketball any improvement in the particular skill by players on a team could help produce greater percentage of wins over the seasons.

TRUNK AND SHOOTING

YVES C.VANLANDEWIJCK et. al state that in most paralympic wheelchair sports active trunk range of movement is assessed by observing shoulder girdle excursion during active trunk movement and is a key determinants of an athlete's classes

4. STUDY LITERATURE

WHEEL CHAIR BASKET BALL

Wheelchair basketball was founded shortly after World War II as a rehabilitation exercise for injured veterans (Malone et al., 2000). Today, wheelchair basketball is one of the most popular of wheelchair sports, and is played competitively in over 75 nations (Malone et al., 2000; Goosey-Tolfrey et al., 2002).

Players are looking to optimize their skills in the game of wheelchair basketball since the aspect of competition has been introduced. Also, as the popularity of wheelchair sports increases, new players will need to learn the necessary skills of the game. According to Brancazio (1981), a person's performance on the basketball court can be improved through the study and application of kinematics and Newtonian mechanics. The knowledge of an optimal free throw movement pattern could help to improve the skills of current players, and shorten the acquisition time by facilitating learning of the skill in new players.

Many studies have addressed the optimal patterns for sport skills in order to increase competence in athletes. However, the area of wheelchair sport has been greatly overlooked. Currently, there are few studies that attempt to optimize skills in wheelchair sports, including wheelchair basketball (Goosey-Tolfrey et al., 2002). It is important that people who use wheelchairs are provided the same opportunities to develop skills and excel in sports.

CLASSIFICATION OF WHEEL CHAIR BASKET BALL PLAYERS:

The IWBF Player Classification System was developed and proposed by Horst Strohkendl of Germany. It was formally adopted by the basketball playing nations in 1982, and used for the first time in a major International tournament at the 1984 Paralympics in England. Over many years the Player Classification System has evolved to be where it is today. The strength of the system is the level of understanding amongst players and coaches, and the open communication and interaction between teams and classifiers.

IWBF players are assigned a classification between 1.0 and 4.5 in half point increments. This classification value is the player's "playing points" on the court. At any given time in a game the total points assigned to a team of five players on court must not exceed 14 – they may be below 14.

THE FUNCTIONS DETERMINING CLASSIFICATION:

The main functions which determine a player's class are:

1) Trunk function

2) Lower limb function

3) Upper limb function

To arrive at a classification the range, strength and coordination of all these functions are taken into consideration, first as individual components, and then as they impact actual basketball situations.

Each class has distinct characteristics unique to that class, which the classifier looks for when making decisions. These characteristics are evident in the basketball skills observed as part of the classification process, and will be detailed in this manual.

In particular, trunk movement and stability form the basis for player classification. Therefore the most commonly used terminology when discussing classification is the player's "volume of action" which is clearly defined for each class.

THE CONCEPT OF VOLUME OF ACTION

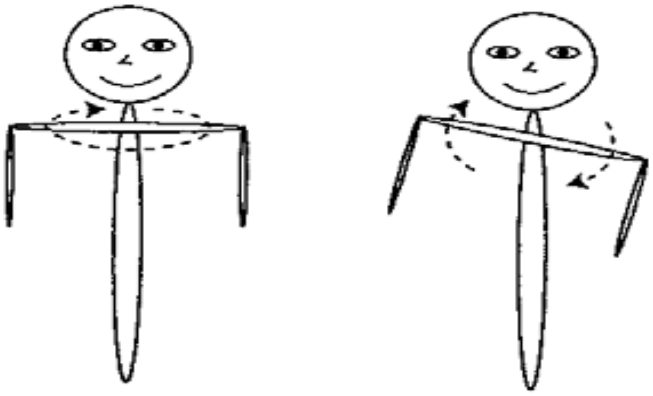
The key element of classification is the observation and assessment of each player's volume of action. The Volume of Action of a player is described as:

The limit to which a player can move voluntarily in any direction, and with control return to the upright seated position, without holding the wheelchair for support or using the upper extremities to aid the movement. The volume of action includes all directions, and describes the position of the ball as if the player were holding it with both hands.

In the seated position, there are several planes of movement available. While these planes have biomechanical names, in order to simplify the definition, they will be referred to as follows:

THE VERTICAL PLANE:

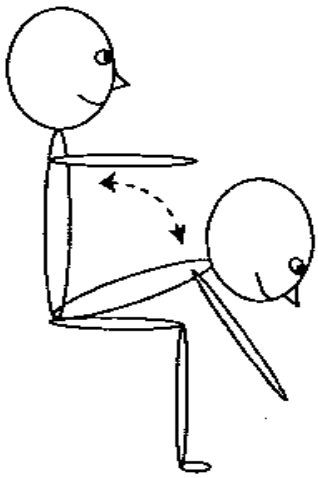
Rotating the trunk to face left or right while maintaining an upright position.



THE FORWARD PLANE:

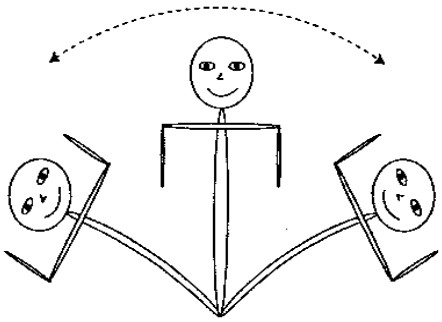
Bending the trunk forward, reaching the hands towards the feet and

returning to the upright position.



THE SIDEWAYS PLANE:

Leaning the trunk to the left or right without movement in the forward plane and returning to the upright position.



CLASSIFICATION AND THEIR VOLUME OF ACTION

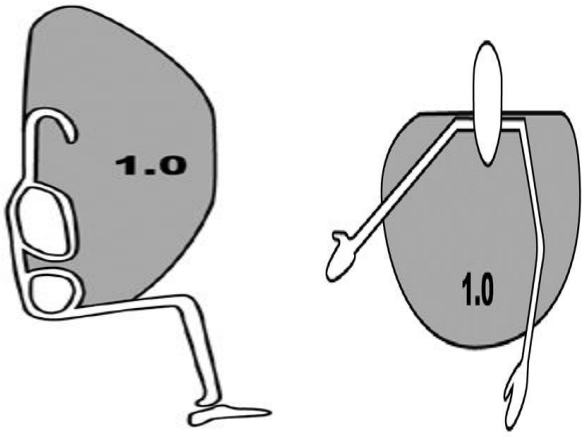
THE CLASS 1.0 PLAYER:

• Has no active trunk movement in the vertical plane (rotation).

• Has little or no controlled trunk movement in the forward plane.

• Has no controlled trunk movement in the sideways plane.

• When unbalanced, has to rely on his arms to return to the upright position.

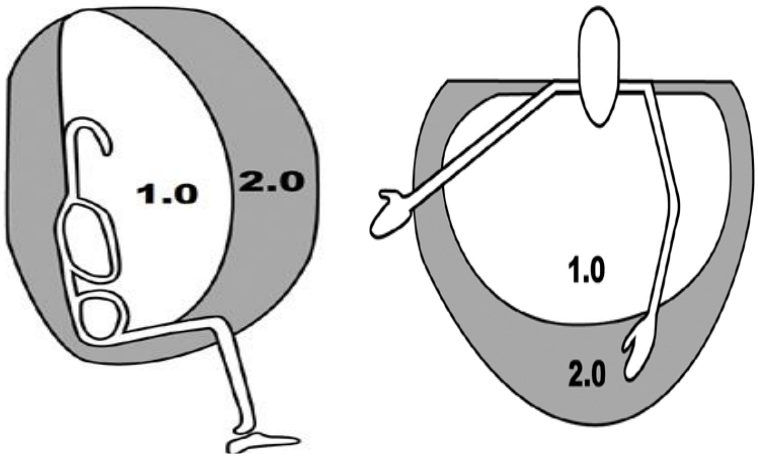


THE CLASS 2.0 PLAYER:

• Has active upper trunk rotation but no lower trunk rotation.

• Has partially controlled trunk movement in the forward plane.

• Has no controlled trunk movements in the sideways plane.

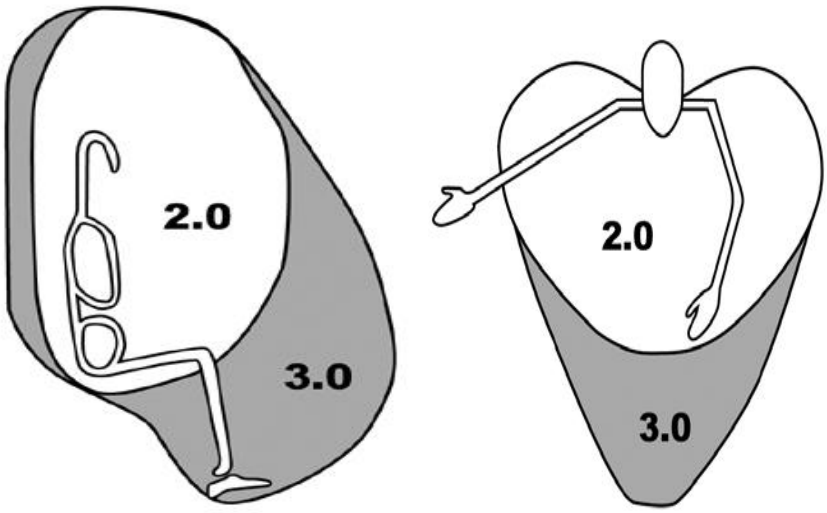


THE CLASS 3.0 PLAYER:

• Has complete trunk movement in the vertical plane.

• Has complete trunk movement in the forward plane.

• Has no controlled trunk movements in the sideways plane.



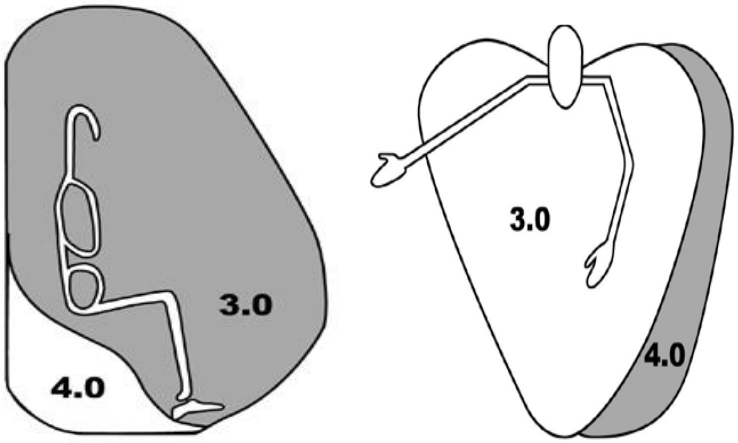
THE CLASS 4.0 PLAYER:

• Has complete trunk movement in the vertical plane.

• Has complete trunk movement in the forward plane.

• Has complete trunk movement to one side, but usually due to limited function in one lower limb

has difficulty with controlled trunk movement to the other side.

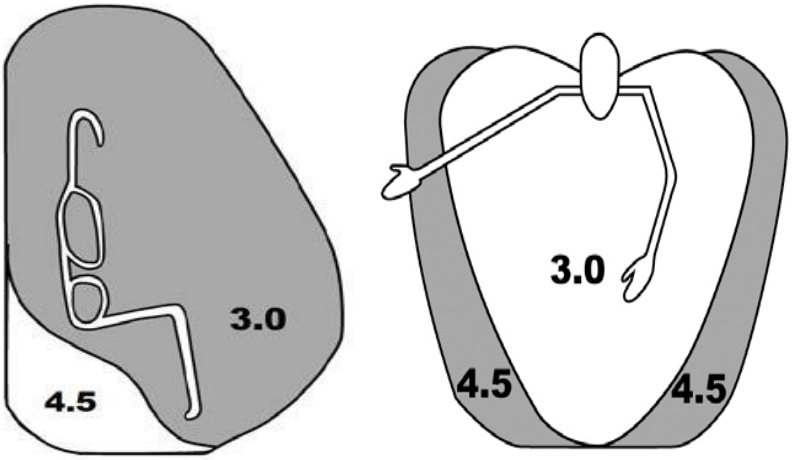


THE CLASS 4.5 PLAYER:

• Has complete trunk movement in the vertical plane.

• Has complete trunk movement in the forward plane.

• Has complete trunk movements to both sides.



There are situations where a player does not seem to fit exactly into one class, exhibiting characteristics of two or more classes. In this instance the classifier may assign the player a half point classification: 1.5, 2.5, or 3.5.

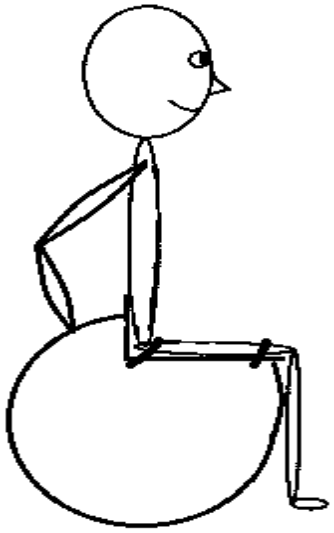
THE CONCEPT OF PELVIC STABILITY

Players adjust their sitting position in the wheelchair to maximize their base of support. A stable base allows for maximum controlled movement of the trunk above, thus optimising the use of the players' volume of action.

Players can be divided into two groups when considering pelvic stability: Those who can actively stabilize their pelvis and those who rely on their wheelchair installation to provide passive stability. It is the ability to stabilize the pelvis which allows a player to have an increased volume of action. It is for this reason that one of the first observation a classifier will make when observing a player is the player's wheelchair installation.

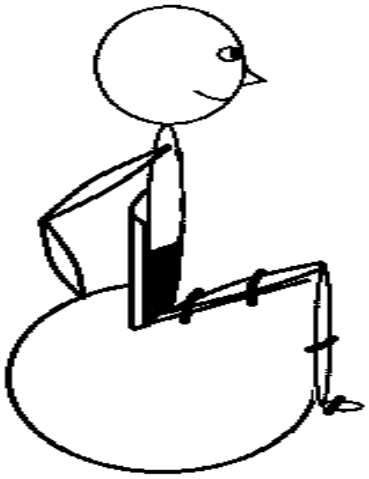
ACTIVE PELVIC STABILITY

Active pelvic stability is when a player has sufficient muscle control in the lower trunk and hips to maintain his pelvis in a normal seated position when he moves his trunk actively through one or more planes of movement. Usually a player with active pelvic stability will be sitting on a relatively flat wheelchair seat, and will require minimal support from the wheelchair installation to maintain an upright sitting position. Players with active pelvic stability typically will be assigned a classification of 3.0 or higher.



PASSIVE PELVIC STABILITY

Passive pelvic stability is when a player does not have sufficient muscle control in the lower trunk and hips to maintain his pelvis in a normal seated position when he moves his trunk through one or more planes of movement. Usually a player with passive pelvic stability will be sitting on a seat significantly angled from front to rear, and relies on the external support of his wheelchair's installation to maintain an upright sitting position. Players with passive pelvic stability typically will be assigned a classification of 2.5 or lower.



ELIGIBILITY CRITERIA

In order to be eligible to play wheelchair basketball in competitions held under the jurisdiction of IWBF a player who does not have a lower extremity impairment which can be clearly established by observation alone will need to apply for consideration of their eligibility to the IWBF.

Eligibility will be determined using the following criteria:

a) A wheelchair basketball player must have a permanent physical disability which, in the opinion of the IWBF, reduces the function of the lower limbs to a degree where they cannot run, pivot or jump at the speed and with the control, safety, stability and endurance required to play running basketball as an able bodied player.

b) The disability must be such that it can be objectively verified by acknowledged medical and/or paramedical investigations such as measurement, X-ray, CT, MRI, etc.

c) Persons who have had hip or knee joint replacements and have provided confirmation of the relevant surgery from their attending physician or surgeon and supporting X-rays/scans are deemed to have met the eligibility criteria.

d) In the instance of amputation, the minimal requirement for eligibility is total removal of the first ray of one foot:

e) In the instance of a leg length discrepancy the minimal requirement for eligibility is a 6cm

difference in leg length as measured from the greater trochanter to the ground in a standing x-ray.

For the purpose of IWBF Classification, degrees of pain are not considered measurable and permanent disabilities.

A player who is deemed eligible to play under the above IWBF criteria shall receive a letter confirming his eligibility. At the first official competition where a classification panel is present the player will present a proposed classification and will be observed during training and game situations. At the end of the competition he will receive his classification card with his official classification.

FREE THROW:

To be successful in wheelchair basketball, players must develop the fundamental skills of the game (Malone, Gervais & Steadward, 2002; Schwark et al., 2004). One fundamental skill in need of development by wheelchair basketball players is free throw shooting. A free throw is a privilege given to a player that has been fouled by another player. The fouled player is given the opportunity to score one point by an unhindered shot for a goal from a position directly behind the free throw line (F.I.B.A., 1980). The free throw should be the easiest shot in basketball since it is not contested. The free throw is classified as a closed, discrete skill as it is performed in a stable, predictable environment with definite start and end points (Malone et al., 2000). Despite this stability, many players struggle with free throw shooting (Vancil, 1996).

Wheelchair basketball players have consistently been found to have free throw shooting percentages that are approximately 20% lower that their standing counterparts (Owen, 1982; Kozar et al, 1994). At the 1994 Men's World Championships, male standing basketball players had free throw shooting percentages ranging from 59-83%, with a mean of 71%, whereas male wheelchair basketball players at the 1992 Paralympic Games had percentages ranging from 35-54%, with a mean of 41% (Malone et al., 2000).

This low free throw shooting percentage can be very costly to a team, as free throws are often the deciding factor in the outcome of a basketball game (Kozar et al., 1994; Malone et al., 2002). In a study by Kozar et al. (1994), they found that free throws account for approximately 20% of the total points in a NCAA Division I men's basketball game. They also found that winning teams scored a significantly higher percentage of their total points from free throws than the losing teams.

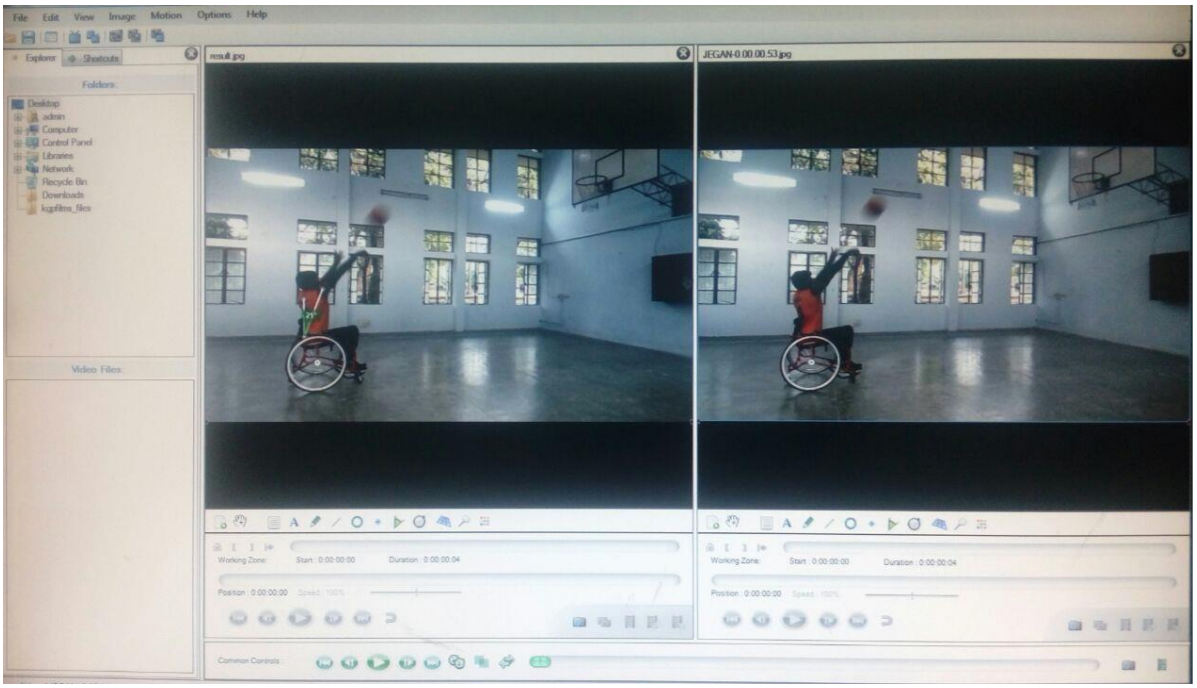
Goosey-Tolfrey et al. (2002) identified important factors affecting wheelchair free throw success to be personal mechanics, arm strength, and trunk stability. Personal mechanics would generally lead to a short shot if the athlete released the ball with too low a speed or angle. A lack of arm strength would lead to a shot falling short if the athlete was not able to generate enough force to release the ball with a high enough speed. A lack of trunk stability causes the shoulder to be positioned lower and thus, the ball is released from a lower position. With a greater distance to travel, the ball must be released with a greater speed. A lack of trunk stability will also make it more difficult to generate force at the shoulder, even with adequate arm strength, as the shoulder is not held in a stable position.

KINOVEA

Kinovea is a software tool to edit the capturing video. It includes several features for the analysis measurement comparison and motion observation of video. Its is 100 % free and open source, kinovea is commonly used for all sports enthusiasts. It helps to slow down the video, study and comment the technique of the players performance. Kinovea software helps to track the body joint, choose the joint to track, path creation, interaction with the path track, configuring display motion.

STEPS TO USE KINOVEA SOFTWARE

- Opening and playing a video
- Specifying the working zone
- Increasing image size
- Slowing down play back speed
- Zooming and magnifying the image



5. METHODOLOGY

5.1 STUDY DESIGN:

Observational cohort study

5.2 SAMPLING METHOD:

Non-probability convenient sampling

5.3 STUDY SIZE:

Total 20 subjects

- Group 1: 3.0 and 3.5 players (n=10)
- Group 2: 4.0 and4.5 players (n=10)

5.4 STUDY SETUP:

Wheelchair basketball ground (Nehru indoor stadium)

5.5 STUDY DURATION:

One month of study includes Classification of players, observe the player while free throw, and video analysis for both the group.

5.6 SUBJECT SELECTION CRITERIA:

INCLUSION:

- Indian players
- 3.0 to 4.5 point players
- Age: 18-30
- Amputees- Above Knee and Below knee
- Spinal cord injury- L1 to L5
- Post Polio Syndrome- Lower Limb
- Congenital anomalies- Lower Limb

EXCLUSION:

- Female athlete
- Any recent injury

5.7 ASSESSMENT TOOL:

- Kinovea [free software]
- Classification chart (IWBF)

5.8 MATERIALS USED:

- A video digital camera
- Leucoplast
- Lap top

6. PROCEDURE

6.1 ASSESSMENT PROCEDURE

Players included in the study are made to fill the consent form and detail explanation about the procedures is given. The total number of 20 players was selected and assessed for 2 2days. According to IWBF classification there are 5 classifications and 3 sub classifications (1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, and 4.5). Among this classification 3.0 3.5, 4.0, 4.5 were included. Players of 3.0 and 3.5 come under Group 1, players of 4.0 and 4.5 under Group 2.

Fig-1: Group 1 (3.0-3.5)

Fig-2: Group 2 (4.0-4.5)

6.2 STUDY PROCEDURE

Free throws taken with high definition video camera (Nikon coolpix L320) with fixed fields of vision. Camera was placed at a distance of 7.5 m away from the free throw line, at an elevation of 3 m from the ground to see trunk motion in sagittal view. The camera was focused from Three Point Line to the Basket to see the successful shots.

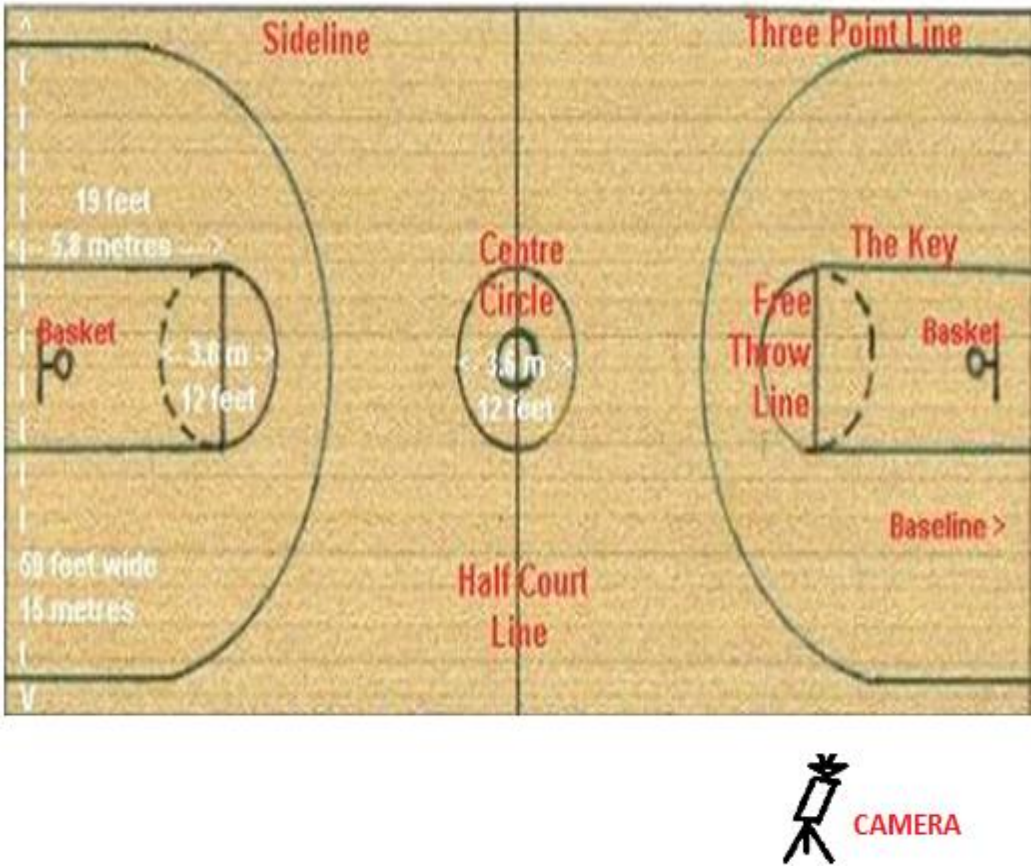


Fig-3

The players were asked to finish their warm up exercises which includes stretching and wall dribbling before entering the court. After warm up session, the anatomical marking were made to detect the trunk motion of individual players using a small piece of leucoplast.

Mark 1: lower angle of wheelchair for stable reference point.

Mart 2: shooting side of shoulder joint (Greater tubercle).

Fig-4

Once marking is done, players enter into the court to perform free throw. Each player were given 5 shots, as the free throw shots commences simultaneously the video recording is captured for the following shots for each player.

Once the overall session is completed the recorded video is copied to the system, the system contains software called Kinovea. This software is used for measuring the trunk inclination angle formed by the reference point on shoulder and lower angle of the wheelchair of players shooting side.during free throw shots.

Fig-5

7. STATISTICAL ANALYSIS

Statistical analysis was done using SPSS software. Data were analyzed in two groups based upon IWBF functional classification: Group 1 (n = 10; consisting of 3.0 and 3.5 points players) and Group 2 (n = 10; consisting of 4 and 4.5 point players). The mean of five shots for each player was calculated, and an independent t test was used to assess the differences in kinematics between the groups.

Group 1 (Trunk motion in Successful shot)

	GROUP	SHOTS	Mean	Std. Deviation
TRUNK MOTION (DEGREE)	3.0 POINT	10	22.40	1.776
	3.5 POINT	15	20.67	3.309

Correlation is no significant at the 0.145 (2-tailed)

Group 2 (Trunk motion in Successful shot)

	GROUP	SHOTS	Mean	Std. Deviation
TRUNK MOTION (DEGREE)	4.0 POINT	14	13.57	3.610
	4.5 POINT	17	7.24	2.412

Correlation is significant at the .000 (2-tailed)

Comparing Group-1 and Group-2 Trunk motion

	GROUP	SHOTS	Mean	Std. Deviation
TRUNK MOTION (DEGREE)	3.0 & 3.5 POINT	50	25.18	4.868
	4.0 & 4.5 POINT	50	13.40	5.810

Correlation is significant at the .00 (2-tailed)

8. RESULTS

The analysis of trunk motion obtained from group-1 players (3.0-3.5) shows no significant difference (0.145), the mean and standard deviation values obtained from 3.0 players for successful shot is 22 degree and 1.77, the mean and standard deviation values obtained from 3.5 players for the successful shot is 20 degree and 3.30.

The analysis of trunk motion obtained from group-2 players (4.0-4.5) shows significant difference (0.00), the mean and standard deviation values obtained from 4.0 players for successful shot is 13 degree and 3.61, the mean and standard deviation values obtained from 4.5 players for the successful shot is 7 degree and 2.41.

The Mean (-SD) values for the analysis of trunk motion obtained for overall free throw shots in group-1 players (3.-3.5) is 25.18 -4.868, and Group-2 players (4.0-4.5) is 13.40 -5.810, thus the study shows there is a significant difference among Group 1 and Group 2 players.

9. DISCUSSION

The present study in analysing the kinematics of trunk shows that the low point players (3.0-3.5) may have different trunk motion to produce successful free throw shot when compared to high point players (4.0-4.5). To produce a successful free throw shot, low point player tend to generate more trunk force when compared to high point player.

Elliott (1992) discusses that 2.0- 2.5 players fall forward toward the basket after ball release, and this lack of stability might have affected their ability to attain successful release parameters. These trunk movements warrant future attention and data examining the trunk dynamics before, during, and after the shot could provide additional information on trunk stability.

Miller and Bartlett (1993) stated that stability during the shooting process is important in eliminating any extraneous body movement, as such movements must be compensated for at release. Players from Group 1 in the present study had less control of the trunk than players in Group 2.

As noted, players in the upper classes used a higher point of release than did players in the lower classes. As indicated by Brancazio (1981), the higher the point of release, the more likely it is that a shot will be successful. The upper classes, therefore, had an advantage over the lower classes in shooting free throws by virtue of having a higher release point. Not Only might players in the upper classes tend to be taller, but they also have the ability to lean the trunk forward and reach the arms upward while shooting without loss of stability.

Thus the trunk movements warrant future attention and data examining, the trunk dynamics before, during, and after the shot could provide additional information for training the wheelchair basketball players. Hence it is very much required to analyse the kinematics of trunk motion in free throw for all IWBF players.

10. CONCLUSION

The study shows that players in Group 1and Group 2 rely on different kinematics of trunk motion to produce successful free throw shot. Hence the study concludes about kinematics of trunk motion which will be useful in present and future to guide the wheelchair basketball Coaches and Sports Physiotherapist to teach wheelchair basketball players to improve their free throw ability. Thus increasing player's proficiency in skill of free throw shooting may help to lead their team to victory.

11. LIMITATIONS AND RECOMMENDATIONS

11.1 LIMITATION

- Other technique (Pushing, Dribbling, Passing, Rebounding)

11.2 RECOMMENDATION

- Improve trunk motion (specific training)
- Posture correction

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1. CONSENT FORM:

Mr. _____ has informed about procedure and the application of Method, and gives my consent in full consciousness for carrying out a research project on me. The researcher has explained me in detail about his project and after understanding clearly about it and its effects and other consequences. I give my consent for carrying out the same.

PLACE:
DATE:

SIGNATURE:

2. WHEELCHAIR BASKETBALL ASSESSMENT FORM:

NAME:

AGE/SEX:

OCCUPATION:

PHYSICAL IMPAIRMENT:

CLASSIFICATION:

SITTING BALANCE:

- FORWARD REACH-
- SIDEWARD REACH-
- OVERHEAD REACH-

TRUNK STABILITY:

- SIDES BEND-
- FORWARD BEND-
- ROTATIONS-

WHEELCHAIR PROPULSION:

NECK STABIITY:

SHOULDER GIRDLE STRENGTH:

ARM STRENGTH:

FOREARM STRENGTH:

HAND GRIP:

SIGNATURE OF INDIVIDUAL **SIGNATURE OF THE EVALUATOR**

3. IWBF CLASSIFICATION

The Class 1.0 Player:

- Has no active trunk movement in the vertical plane (rotation).
- Has little or no controlled trunk movement in the forward plane.
- Has no controlled trunk movement in the sideways plane.
- When unbalanced, has to rely on his arms to return to the upright position.

The Class 2.0 Player:

- Has active upper trunk rotation but no lower trunk rotation.
- Has partially controlled trunk movement in the forward plane.
- Has no controlled trunk movementsin the sideways plane.

The Class 3.0 Player:

- Has complete trunk movement in the vertical plane.
- Has complete trunk movement in the forward plane.
- Has no controlled trunk movementsin the sideways plane.

The Class 4.0 Player:

- Has complete trunk movement in the vertical plane.
- Has complete trunk movement in the forward plane.
- Has complete trunk movement to one side, but usually due to limited function in one lower limb has difficulty with controlled trunk movement to the other side.

The Class 4.5 Player:

- Has complete trunk movement in the vertical plane.
- Has complete trunk movement in the forward plane.
- Has complete trunk movements to both sides.

4. MASTER CHART-1

3.0 POINT

PLAYER-1	
RESULTS	**DEGREE**
NO BASKET	29
BASKET	21
NO BASKET	27
NO BASKET	21
NO BASKET	25

PLAYER-2	
RESULTS	**DEGREE**
BASKET	23
BASKET	22
NO BASKET	32
NO BASKET	31
BASKET	20

PLAYER-3	
RESULTS	**DEGREE**
BASKET	24
NO BASKET	32
NO BASKET	28
NO BASKET	35
BASKET	22

PLAYER-4	
RESULTS	**DEGREE**
NO BASKET	31
NO BASKET	30
NO BASKET	29
NO BASKET	28
NO BASKET	29

PLAYER-5	
RESULTS	**DEGREE**
BASKET	21
BASKET	25
NO BASKET	30
BASKET	21
BASKET	25

3.5 POINT

PLAYER-6	
RESULTS	**DEGREE**
NO BASKET	24
NO BASKET	28
BASKET	18
BASKET	19
BASKET	20

PLAYER-7	
RESULTS	**DEGREE**
NO BASKET	30
NO BASKET	29
NO BASKET	35
NO BASKET	28
NO BASKET	26

PLAYER-8	
RESULTS	**DEGREE**
BASKET	22
BASKET	25
BASKET	20
BASKET	21
BASKET	16

PLAYER-9	
RESULTS	**DEGREE**
NO BASKET	27
NO BASKET	30
BASKET	19
BASKET	17
BASKET	19

PLAYER-10	
RESULTS	**DEGREE**
BASKET	29
BASKET	24
BASKET	20
BASKET	21
NO BASKET	31

5. MASTER CHART-2

4.0 POINT

PLAYER-11	
RESULTS	**DEGREE**
NO BASKET	16
NO BASKET	14
BASKET	23
NO BASKET	21
BASKET	17

PLAYER-12	
RESULTS	**DEGREE**
BASKET	12
BASKET	11
BASKET	14
BASKET	13
BASKET	10

PLAYER-13	
RESULTS	**DEGREE**
BASKET	17
BASKET	12
NO BASKET	22
NO BASKET	20
NO BASKET	21

PLAYER-14	
RESULTS	**DEGREE**
NO BASKET	22
BASKET	11
BASKET	10
NO BASKET	25
NO BASKET	24

PLAYER-15	
RESULTS	**DEGREE**
NO BASKET	19
NO BASKET	15
BASKET	11
BASKET	16
BASKET	13

4.5 POINT

PLAYER-16	
RESULTS	**DEGREE**
BASKET	6
BASKET	4
BASKET	6
BASKET	7
BASKET	6

PLAYER-17	
RESULTS	**DEGREE**
BASKET	5
BASKET	8
NO BASKET	19
BASKET	7
BASKET	4

PLAYER-18	
RESULTS	**DEGREE**
BASKET	5
NO BASKET	15
NO BASKET	17
NO BASKET	16
BASKET	6

PLAYER-19	
RESULTS	**DEGREE**
BASKET	9
BASKET	10
BASKET	8
BASKET	9
NO BASKET	18

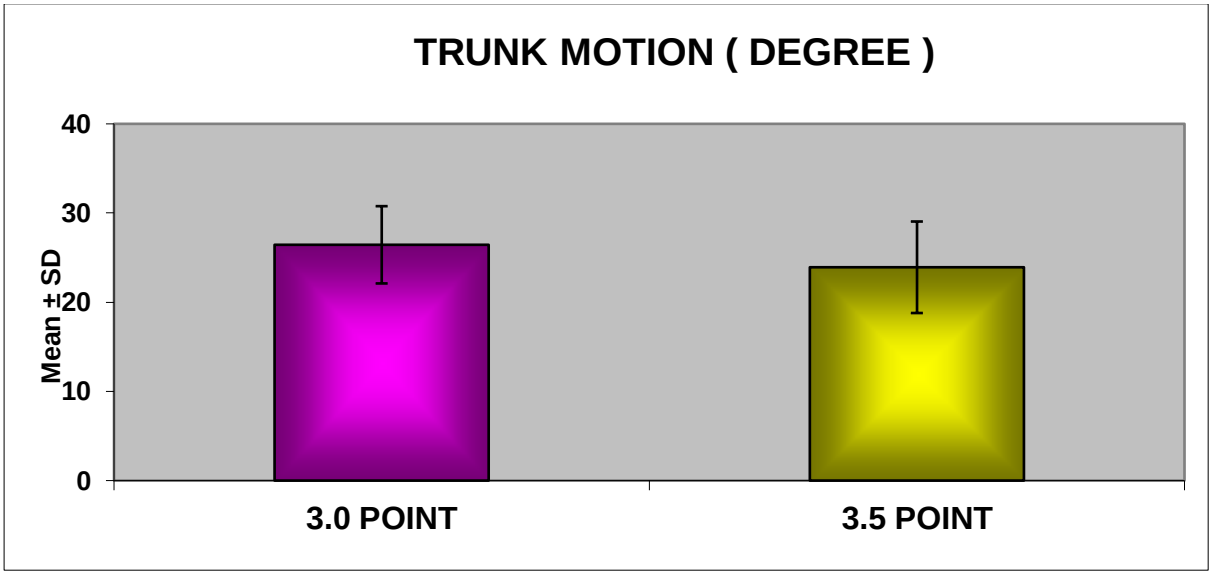
PLAYER-20	
RESULTS	**DEGREE**
BASKET	10
NO BASKET	19
NO BASKET	20
NO BASKET	14
BASKET	13

6. MASTER CHART-3

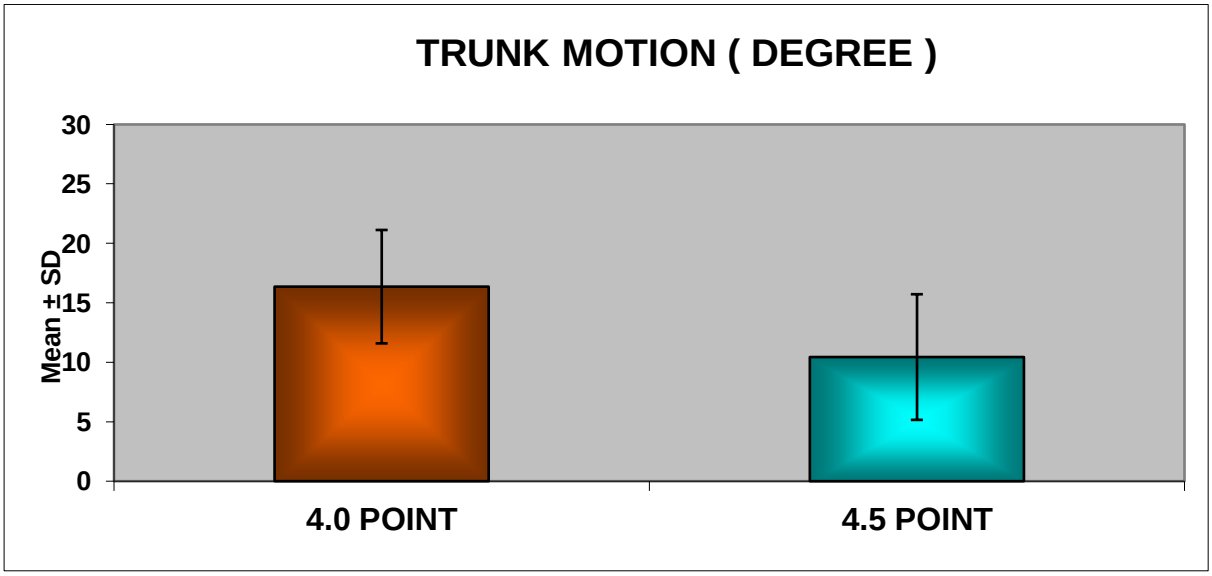
PLAYERS	AGE	DISABILITY	POINT
1	25	B/L LL PPS	3.0
2	27	SCI L1-L2	3.0
3	26	B/L AK AMPUTEE	3.0
4	22	RT. LL PPS	3.0
5	24	LT. LL PPS	3.0
6	24	CONGENITAL B/L LL ANOMALY	3.5
7	22	SCI-L5	3.5
8	30	B/L LL PPS	3.5
9	22	CONGENITAL B/L LL ANOMALY	3.5
10	28	SCI-L4	3.5
11	22	LT. AK AMPUTEE	4.0
12	28	RT. LL MILD PPS	4.0
13	24	LT AK AMPUTEE	4.0
14	21	LT. LL-PPS	4.0
15	29	SCI-L5	4.0
16	22	RT. BK AMPUTEE	4.5
17	30	LT. BK AMPUTEE	4.5
18	27	LT. BK AMPUTEE	4.5
19	25	LT. BK AMPUTEE	4.5
20	29	RT. MILD PPS	4.5

7. BAR DIAGRAMS

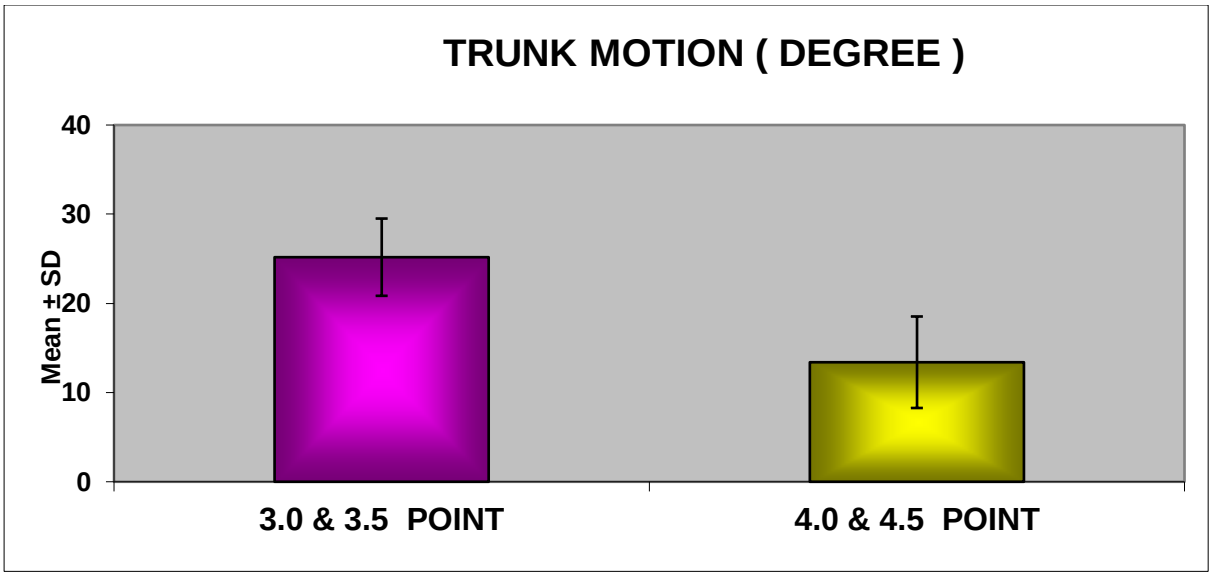
BAR DIAGRAM SHOWS MEAN AND SD VALUE OF TRUNK MOTION IN GROUP-1 FOR SUCCESSFUL SHOT



BAR DIAGRAM SHOWS MEAN AND SD VALUE OF TRUNK MOTION IN GROUP-2 FOR SUCCESSFUL SHOT



BAR DIAGRAM SHOWS COMPARISON OF MEAN AND SD VALUE OF TRUNK MOTION OF GROUP-1 AND GROUP-2 IN FREE THROW SHOT



8. GRANT LETTER-1

To:

MR.ANANDA JOTHI, (TECHNICAL DIRECTOR),

Wheelchair Basketball Federation of India,

Chennai- 600034.

Respected Sir/Mam,

Sub: Seeking Permission to observe players for project – Regarding.

I hereby certify that **Mr.Ranjith Kumar** is a bonafide student of Mohamed Sathak A.J.College of Physiotherapy studying in MPT (Sports) degree course. I Request you to grant permission to observe and study the athletes for twenty days towards the preparation of the project.

PRINCIPAL

Station: Chennai

Institution Seal:

9. GRANT LETTER-2

TO:

THE PRINCIPAL,

Mohamed Sathak A.J. College of Physiotherapy,

Chennai- 600034.

Sir /Madam,

Sub: Granting Permission to observe the players for project – Regarding.

Ref: Your letter seeking permission.

I grant permission to, **Mr. Ranjith Kumar** student of Mohamed Sathak A.J. College of Physiotherapy studying in MPT (Sports) degree course to observe and Study the players for one month towards the preparation of the project. I am also aware of the study and its procedure to be carried out in this study.

C.ANANADA JOTHI

(TECHNICAL DIRECTOR)

Station: Chennai